## A Diſcourſe on this PROBLEM;

*Why* Bodies *diſſolved in Menſtrua Specifically lighter than themſelves ſwim therein.*

By Mr. *WILLIAM MOLYNEUX*, of *Dublin.* Member of the *Royal Society.*

THe Liberty of Philoſophiſing being now univerſally granted between all men, I am ſure that a difference in Opinion will be no breach of affection between two intirely Loving Brothers: And therefore I ſhall take the freedom to Propoſe my Own thoughts in a matter wherein my Brother Mr. *Thomas Molyneux* hath Appeared publickly in the *Novelles de la Republique des Lettres*, *Mois d' Aout* 1684. *Art* 4. and *Mois de Janvier* 1685. *Art.* 7. The Problem propoſed is, *Why Bodies diſſolved float in Liquors lighter than themſelves*; as for Example: Mercury diſſolved in ſtrong Spirit of Nirte ſwims therein, tho' each ſmall Particle of Mercury, be far heavyer than ſo much of the Liquor whoſe place it occupies. This, ſays he, cannot be ſolved by the prime Law of Hydroſtaticks, which is, that a Body which in an equal Quantity is heavyer than a like quantity of Liquor, ſinks in that Liquor; thus a Cubick Inch of Iron being heavier than a Cubick Inch of *Aqua-Fortis*, and each Particle (how ſmall ſoever) of Iron being heavier then a like Particle of *Aqua-Fortis*; Iron being put into *Aqua-Fortis* ſhould ſink, and yet we find, that Iron being diſſolved in a convenient Quantity of *Aqua-Fortis* floats therein, and does not fall to the Bottom. The Reaſon which my Brother gives for this is, that the Internal Motion of the Parts of the Liquor, does keep up the Particles of the diſ-

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ſolved Solid, for they being ſo very Minute, are Moveable by the leaſt Force imaginable, and the Action of the Particles of the *Menſtruum*, is ſufficient to drive the Atomes of the diſſolved ſolid Body from place to place; and conſequently, notwithſtanding their Gravity, they do not ſink in the Liquor lighter than themſelves. As a Proof of this in the *7th.* Article of *Janvier* 1685, he offers an Experiment known in *Chymiſtry*, that a *Menſtruum* over a digeſting Fire (as the *Chymiſt* ſpeaks) will diſſolve a greater Quantity of a Body put into it, than when 'tis off the Fire, and if it be taken off the Fire, and ſuffered to cool, a great Portion will precipitate of that which was perfectly diſſolved, whilſt the *Menſtruum* continued hot. For, *ſays he*, the Particles of the *Menſtruum* acquire a more violent agitation by the Fire, and are therefore able to raiſe and keep up a greater Quantity of the diſſolved Body, or hereby they are able to Reſiſt a greater Gravity.

It has been objected againſt this Notion, that the common Experiment of precipitation, by mixing an *Alkaly* with an *Acid*, ſeems to contradict this; for thereby the Fluidity of the *Menſtruum* is not taken away, and conſequently, the internal Agitation of its Parts is not diminiſhed, and yet thereupon, the Particles of the diſſolved Body precipitate all to the Bottom. To this he anſwers in the forecited Article of *January*, that all Mixtures of different Liquors introduce in each a different Conformation of Pores, and therefore the Infuſion of a new Liquor, drives the inſenſible Parts of the diſſolved Body from their Places, and forces them to ſtrike againſt each other, and cling together, and ſo becoming more big and heavyer than formerly, the internal Agitation of the Liquor is no longer able to move and ſuſtain them, and conſequently they fall to the Bottom.

This, as fairly and ſhortly as I can propoſe it, is his Sentiment of this Phænomenon.

But I conceive another Account may be given of this Appearance, and that the foreſaid Law of *Hydroſtaticks* is a little deficient. 'Tis true indeed, if we conſider only the ſpecifick Gravity of a Liquor, and the ſpecifick Gravity of a ſolid Particle floating therein, the forementioned Rule is exact; but in ſinking there is a requiſite ſeparation of the Parts of the Liquor by the ſinking Body; and there being a natural Inclination in the Parts of all Liquors to Union, ariſing from an Agreement or Congruity of their Parts, there is a reſiſtance therein to any thing that ſeparates this Conjunction: Now unleſs a Body have weight enough to overcome this Congruity or Union of Parts, ſuch a Body will float in a Liquor ſpecifically lighter than it ſelf. But that a heavy Body, as *Mercury* or *Iron* may have its Parts reduced to that Minuteneſs, that their Gravity or Tendency downwards, is not ſtrong enough to ſeparate the Coheſion or Union of the Parts of a Liquor, will be manifeſt, if we conſider, that the Reſiſtance made by the *Medium* to a falling Body, is according to the Superficies of the Body; but as the Body decreaſes in Bulk, its Superficies does not proportionably decreaſe; thus a Sphere of an Inch Diameter, has not eight times leſs Superficies than a Sphere of two Inches Diameter, tho' it have eight times leſs Bulk, and conſequently paſſing through a *Medium*, as ſuppoſe Air or Water, the Sphere of an Inch Diameter is, proportionably to its Bulk, more reſiſted, than a Sphere of two Inches Diameter in proportion to its Bulk; and hence it will come to paſs, that at laſt a Body may be reduced to that Minuteneſs, that its Gravity preſſing downwards (which is according to its Bulk) may be leſs than the reſiſtance of the *Medium*, which operates on the Surface of the Body; ſeeing as I ſaid before, the Surfaces of Bodies do not decreaſe ſo faſt as their Bulks, theſe decreaſing in a *Triplicate*, but thoſe in a *Duplicate Ratio* of the Bodies Diameters.

This Account does not at all oppoſe the Experiment of a *Menſtruum* over the Fire, being able to diſſolve or ſuſtain

a greater Quantity of a heavy Body; for the Reaſon of this, as 'tis given by my Brother, does not Contradict my Notion. The Account likewiſe, that He gives of Chymical Precipitation agrees very well with what I propoſe: So that of theſe I ſhall ſay no more.

But becauſe in the beginning of my Diſcourſe, I ſay that the forementioned Law of *Hydroſtaticks* is a little defective, I deſire to explain my ſelf a little further in that Point. In Weights falling through the Air, were Gravity only conſider'd, the Proportions of their Deſcents would be exactly as *Galileo* has Demonſtrated; but it is allow'd by all, that the Reſiſtance of the Air, not being conſider'd in thoſe Demonſtrations, they are not Mathematically true in Practice, but that Really there is ſomething of that Proportion hindred by the Airs Reſiſtance. Now, what is this leſs than to ſay, that the Reſiſtance of the Air takes off ſome of the Operation of Gravity, or is able to withſtand or oppoſe part of its Action? And if ſo, what ſhall we ſay, were an Iron Sphere let through a Medium of Water? Surely the Proportions of its deſcents would be much more diſturbed herein, as Water is much more ſolid and difficult to be ſeparated or paſſed through than Air, and conſequently we muſt needs Grant, that more of the Operation of Gravity, is taken off or Reſiſted by this Oppoſition of the Water, than that of the Air. And if ſo, Surely there may be a certain degree of Gravity, that may be quite taken off by the Reſiſtance of the Water: Were a Piſtol Bullet let fall through the Air, it would Deſcend imperceptibly nigh the Proportions that *Galileo* has aſſigned, but were a ſingle grain of Sand ſo let fall, it would be much hindred in its Courſe, and the half of this Grain would be more obſtructed; what ſhall we then ſay of the ten thouſandth part, or of a part the ten thouſand millionth of this, and again of the Infinite Subdiviſions of that, till at laſt we come to a part that would be wholly reſiſted, or kept up;

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ſuch as I conceive the Minute particles of a Body diſſolved in a *Menſtruum.*

On this account 'tis I ſay, that the forementioned Principle of *Hydroſtaticks* is a little defective; for it conſiders not the Natural Congruity of the Parts of a Liquor, whereby they deſire, as 'twere, to unite and keep together, juſt as we ſee two Drops of Water on a Dry Board being brought together do jump and Coaleſce, and therefore Liquors have an innate Power of Reſiſting a certain degree of force that would ſeparate them; ſuch as I ſuppoſe the degree of Gravity in the moſt Minute Particles of a Body diſſolved in a *Menſtruum.*

The forementioned Rule holds true to the moſt nice Senſe in Great Bodies but in thoſe that are by many Millions of Diviſions Smaller, it ſeems to fail.

This in ſhort is my Conjecture in this matter, which I propoſe, as my Brother did his, with all ſubmiſſion imaginable, and thereby to give occaſion to others to enquire into the Cauſes of this appearance, rather than to publiſh my own ſentiment, as the undoubted ſolution thereof.

But this I muſt acknowledge, that the Internal motion of the parts of a Liquor ſeems ſo very agreeable to truth, and explicates ſo many Phænomenea eaſily and plainly, that I would not be thought to deny it. Neither would I be thought wholly to Reject my Brothers ſolution of this Problem; for certainly that Motion (whatſoever it is) in a *Menſtruum*, which is able to Diſſolve ſuch a ſolid Body as Iron, that is, which is able to diſturb the cloſe and ſtrong Coheſion of the Parts of Iron, may very well be ſuppoſed ſufficient to diſturb or keep up theſe parts from reſting in the Bottom of the Veſſel, wherein the ſolution was made; And certainly no better account can poſſibly be given of ſuch ſolutions, than by ſuppoſing ſuch an Internal motion in the Parts of the *Menſtruum* inſinuating themſelves into the ſolid body, and looſening its Parts. And tho' it may be objected, that in the Parts of Water there may be ſuppoſed

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as Violent an Internal motion, as in the Parts of *Aqua-Fortis*, and yet we ſee Water will not diſſolve Iron, as *Aqua-Fortis* does, and Common Bees-Wax is diſturbed by neither of them, I leave the Nice Enquiry after this point to others, *viz.* What kind of Motion and peculiar Conformation of parts is requiſite both in the *Menſtruum* and in the Diſſolved Body, that a ſolution may reſult from their Commixture.

## *Some Reflections on the foregoing Paper by Mr.* T. M.

What my Brother has laid down in this Diſcourſe, I think does moſt undeniably evince that the received Law of *Hydroſtaticks* is ſomewhat defective. For Liquors, tho' they are Fluid yet they are Bodies, and therefore conſiſt of parts united; which Union tho' it be eaſily deſtroy'd, yet of neceſſity it requires ſome degree of Force for the effecting it; nor is it more manifeſt, if rightly conſider'd, that a Flint requires Force for the ſeparation of its parts, than that Fluids do for theirs. But however, I imagine, this Property ought not to be rely'd upon as the ſole Cauſe of this Appearance, to which my Brother has apply'd it; nay perhaps does not ſo much as concur the leaſt in the producing this effect; my Reaſon in ſhort is this: whatever is of ſufficient Power to raiſe the minute Particles of a *Heavy Body* in a light Fluid, is certainly a ſufficient cauſe to keep them in that ſtate: now my Suppoſition may give ſome account of this; what my Brother ſays, never can; for he muſt neceſſarily ſuppoſe them firſt raiſed; and then he gives the reaſon of their not ſinking: Whereas 'tis not to be queſtioned but that that Force which raiſed them, is the ſame that keeps them from falling to the bottom.

But theſe Conjectures (for I eſteem them no more) I leave to the Conſideration of thoſe that deſire to enquire further into this Matter.